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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Litter Production by Oak-Mountainmahogany Chaparral
in Central Arizona¹

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Annual litter fall from shrub live oak was 192 g/m² crown area on southerly slopes, and 138 g on northerly slopes. For the chaparral community as a whole, southerly aspects produced 193 g/m² crown areas and northerly aspects, 215 g. Most litter fell during late spring and early summer, least in fall and early winter. Forest floor varied from 9.2 to 27.1 metric tons per ha. Maximum water retained against free drainage was 4.8 mm under shrub live oak and 5.1 mm under Pringle manzanita.

Keywords: Chaparral, litter, oak, mountainmahogany, biomass, forest floor, *Cercocarpus montanus*, *Quercus turbinella*.

Chaparral is the dominant vegetation on some 1.6 million ha (4 million acres) in Arizona. Litter production and accumulation under this evergreen shrub cover has important effects on soil protection and consumptive water use, because the communities exist on steep slopes with highly erodible soils.

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Litter production and accumulation ("forest floor") was studied intensively by Kittredge (1955) in the chaparral of southern California. He found significant differences between chaparral subtypes, and between young and old stands, both in annual production and accumulation. Nineteen-year means of annual litter accumulation ranged from 1.51 to 3.19 metric tons per ha in Bell Canyon, and 4-year averages ranged from 0.52 to 4.96 metric tons per ha in Fern Canyon. Weight of forest floor, or total accumulated litter, was calculated to range between 8.4 and 111.9 metric tons per ha at equilibrium, the point where annual accumulation equals annual decomposition. Kittredge estimated that about 12 metric tons of forest floor per ha would provide adequate watershed protection against erosion.

Glendening and Pase (1964) measured forest floor of 46.2 metric tons per ha under a dense, mature stand of Pringle manzanita (Arcto-

staphylos pringlei Parry) in central Arizona. Litter depth was 3.5 cm. Forest floor depth of 1.3 cm or greater adequately controlled erosion in a ponderosa pine (Pinus ponderosa Laws.) area in California (Rowe 1955).

Precipitation intercepted and retained by litter affects the soil moisture regime, especially when moisture is derived from small showers. Kittredge found moisture retention storage to vary from 12 percent under chamise and Eastwood manzanita to 187 percent under chaparral whitethorn. Under Quercus dumosa Nutt., a shrub closely related to shrub live oak (Quercus turbinella Greene), retention storage was 157 percent.

The purposes of this study were to determine (1) the annual litter fall under shrub live oak and under a mixed chaparral stand, and to relate this litter fall to aspect, shrub size, and season of year; (2) weight of the forest floor; and (3) litter moisture retention capacity.

Study Area and Methods

Study sites were located in the Sierra Ancha Experimental Forest about 55 km north of Globe, Arizona, and in the Mazatzal Mountains within the Tonto National Forest.

Northerly (fig. 1) and southerly (fig. 2) aspect collection sites on the Experimental Forest were located at 1,500 and 1,585 m elevation, respectively, about 1.5 km apart. Both sites on the Experimental Forest were on deeply weathered diabase parent material. Soils, tentatively classified as Jayaar sandy loam, were coarse and almost structureless, with high infiltration capacity. Regolith varied from 2 to 3 m deep.

Shrub live oak was dominant, with true mountainmahogany (Cercocarpus montanus Raf.), manzanita (Arctostaphylos spp.) and Wright silktassel (Garrya wrightii Torr.) as common associates. The stand had not burned over for at least the last 75 years, as determined by ring counts on occasional ponderosa pine trees in swales (Pase and Johnson 1968).

Annual rainfall at Headquarters Climatic Station, midway between the two sites, has averaged 630 mm since 1914. Approximately 30 percent of this falls during the summer growing season, June through September—an unusual situation for “Mediterranean” type vegetation. Two dry seasons usually occur—April-June, and September-October.

Nine mature shrub live oak plants at each site were caged with hardware cloth to trap all litter produced. A floor of screen wire was fitted beneath each plant. Litter was collected monthly, as far as possible, from July 1962



Figure 1.—Litter collection area on south-facing chaparral slope near Sierra Ancha Headquarters.

Figure 2.—Pocket Creek drainage. Arrow points to north-facing litter collection site.



through September 1965. When weather delayed collection, the litter was prorated to a monthly basis.

Before the cages were placed, four 929 cm² (1 ft²) samples of forest floor were collected under each shrub live oak. The "L" layer consisting of fresh, intact litter and "F" layer consisting of partially decomposed litter were measured for depth, then collected and oven-dried.

To sample litter fall from the shrub community in general, 33 litter baskets 929 cm² in area were placed under shrubs on each of the two aspects. These baskets were collected quarterly, and litter fall prorated to the following periods: spring, March 21 to June 20; summer, June 21 to September 20; fall, September 21 to December 20; and winter, December 21 to March 20. Litter baskets were collected for 3 years, beginning in the fall of 1962. Although baskets were placed on slopes, litter weights were adjusted to reflect horizontal areas.

One collection site for determining moisture-retention capacity under a dense Pringle manzanita stand was located in the Mazatzal Mountains. Elevation of this site was 1,740 m, on deeply weathered granitic parent material. Soil was of the Barkerville series, coarse with

high infiltration capacity, but with some clay in the subsoil. Slopes were less than 50 percent on all sites.

For determination of moisture-retention capacity, 16 circular 12.7 cm diameter disturbed-litter samples were randomly selected from one shrub live oak and two Pringle manzanita communities. The "L" and "F" layers were collected together; rock fragments and soil aggregates were removed by hand. Water-holding capacity was determined as outlined by Kittredge (1955) and modified by Bernard (1963). Litter samples in metal cylinders with cheesecloth bottoms were soaked in water for 48 hours, then drained on damp sand for 48 hours. Cylinders were covered with plastic to reduce evaporation. The drained litter was weighed and oven-dried at 102° C for 48 hours.

Relative leaf mass on northerly versus southerly aspects was determined by cutting 111 shrub live oak stems on the northerly aspects, 100 on southerly aspects, then stripping and oven-drying the leaves. Stem diameters were measured near ground level, above any swelling.

Crown cover of the chaparral stand was determined by nine 100-foot line intercept transects on each of the two aspects.

Results

Litter Production

Shrub live oak produced an annual litter mass of 137.5 g m^{-2} of projected crown area on northerly slopes, and 192.1 g m^{-2} on southerly slopes. Because the shrubs were selected for suitability for caging as well as comparable size and health, no statistical comparison is valid (Kemp 1965). On the basis of 42.8 percent shrub live oak cover on northerly slopes and 40.2 percent on southerly slopes, this represents 588 kg and 772 kg shrub live oak litter per ha, respectively.

Virtually 100 percent of the leaves on healthy shrub live oaks were replaced each year—few leaves remained on the shrubs from one growing season to the next. On southerly aspects most litter was shed in April and May, followed by an abrupt decline that reached its low point in January. Litter yield from north-slope shrub live oaks, however, was shed more uniformly from April through August, and reached a low point also in January (fig. 3). Leaves comprised by far the greatest percent of annual litter shed:

	Northerly slopes	Southerly slopes
	(Percent)	
Catkins	1.75	4.22
Leaves	91.74	87.75
Twigs and bark	3.24	5.16
Acorns	2.26	2.55
Acorn cups	1.01	.32

Volume index (crown area \times height) was only a slightly better estimator of litter production than projected crown area ($r = 0.965$ vs $r = 0.946$), because the individual caged shrubs were relatively uniform in height. Annual litter fall increased approximately 0.1 kg for each cubic meter increase in shrub crown volume (fig. 4).

Shrub live oak leaf mass in this mature chaparral community was closely related to stem basal area (fig. 5). There was no significant difference between northerly and southerly slopes. Stems varied considerably in height, so incorporation of this parameter would likely have reduced the variance of the leaf mass-basal area regression.

Litter yield from the total chaparral community was significantly higher on north- than on south-facing aspects. Litter baskets placed within the crown canopy collected a 3-year average of 193 g m^{-2} on southerly slopes—similar to the annual rate found under shrub live oak. When corrected for 18 percent bare ground, on which the annual litter accumulation was unknown but very low, litter fall amounted to 1,580 kg per ha. On northerly slopes, however, litter fall per square meter from the total stand was substantially higher than from shrub live oak alone. Litter basket collections showed a litter fall of 215 g m^{-2} within the canopy. When corrected for 19 percent bare ground, this is equivalent to 1,740 kg per ha. Shrub live oak, with 52 percent of the shrub composition, produced only 34 percent of the total north-slope litter.

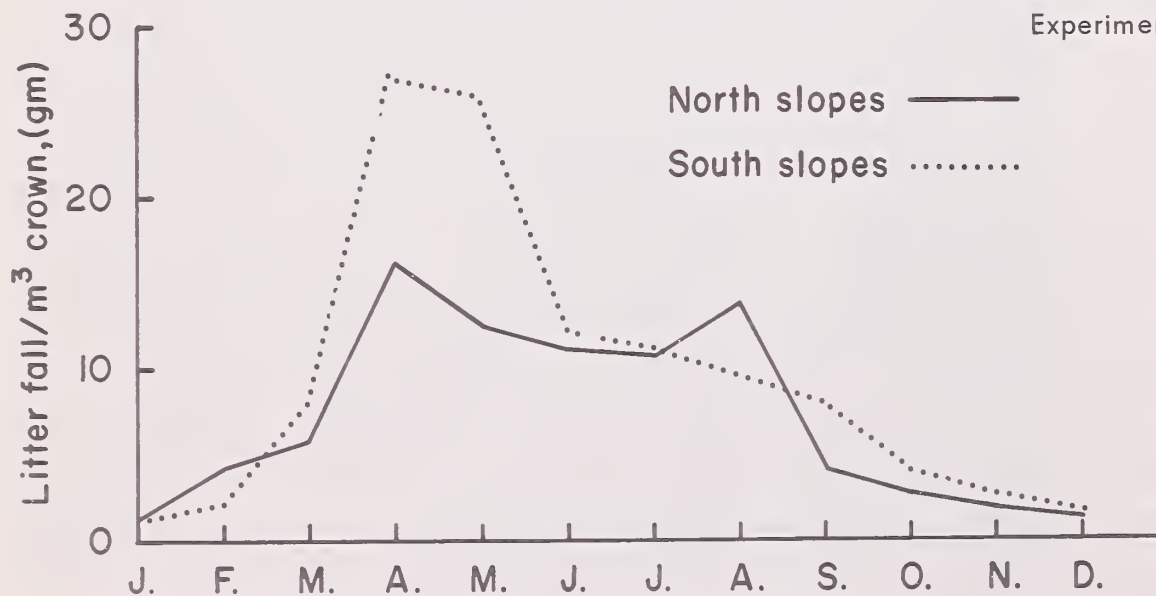


Figure 3.—Monthly litter fall from mature shrub live oaks on the Sierra Ancha Experimental Forest.

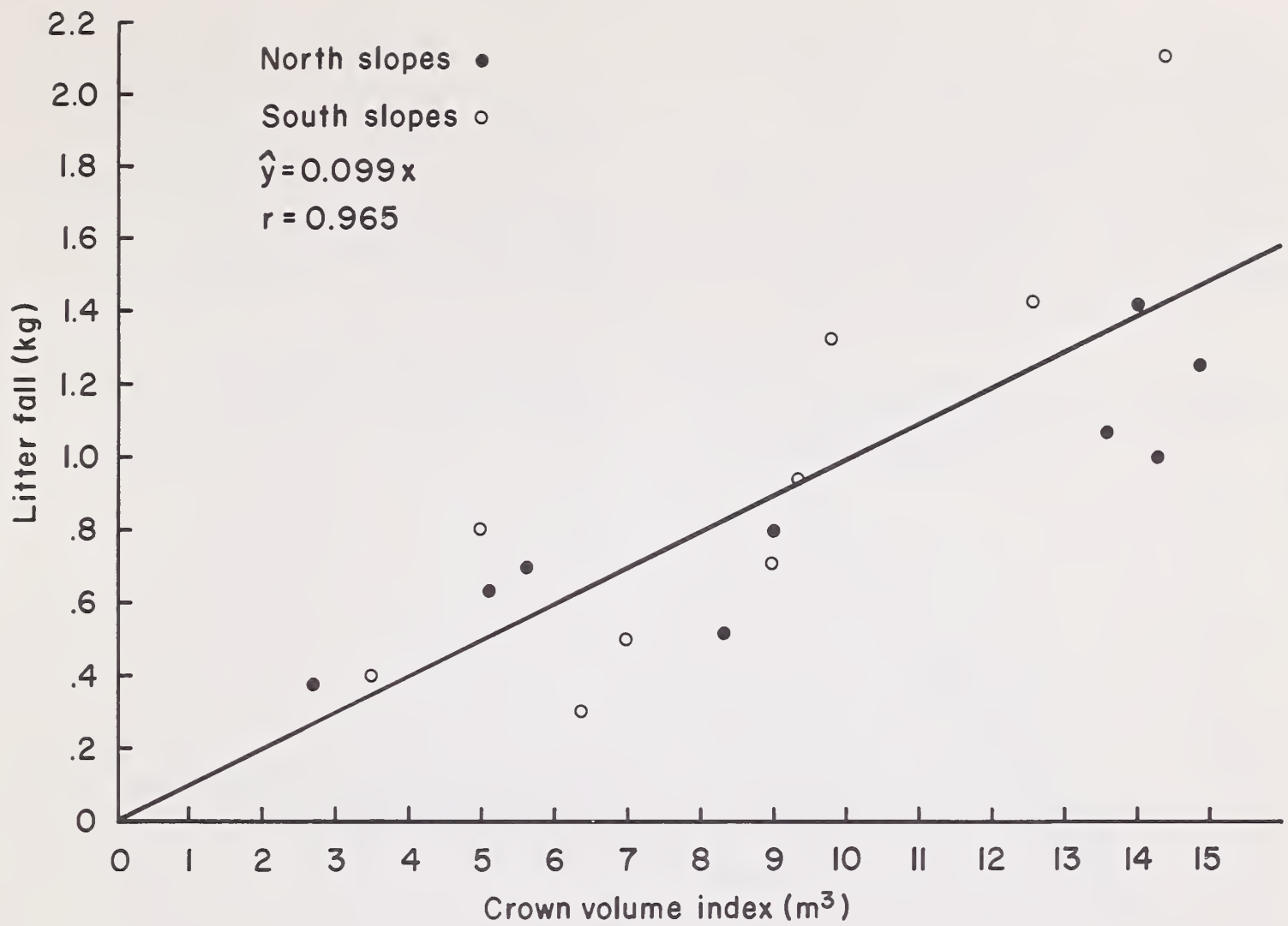


Figure 4.—Shrub live oak litter production as a function of crown volume index.

The peak of litter fall for the chaparral community as a whole was somewhat later than for shrub live oak alone. On both aspects, most litter fell during the summer, and least in the fall:

	North (g/m ²)	South
Spring	34.2	32.6
Summer	77.2	70.5
Fall	27.5	21.4
Winter	<u>34.2</u>	<u>32.6</u>
Total	215.3	193.2

Weight of Forest Floor

The lower shrub live oak litter production on north-facing slopes resulted in lower forest floor weights. On northerly slopes, total forest floor under the nine caged oaks averaged 9.2

metric tons per ha; on southerly slopes it averaged 16.4 metric tons per ha:

	Thickness (cm)	Ovendry weight (metric tons/ha)
North:		
L layer	0.25	0.8
F layer	2.44	8.4
South:		
L layer	0.25	1.8
F layer	2.31	14.6

Forest floor under three dense, mature, east-facing chaparral stands—one shrub live oak and two Pringle manzanita—was substantially heavier than under the individual caged shrub live oak plants. Litter mass in the combined "L" and "F" layers was 27.1 ± 1.2 metric tons per ha under predominantly shrub live oak, and 25.1 ± 1.2 under Pringle manzanita. These massive, well-developed stands probably

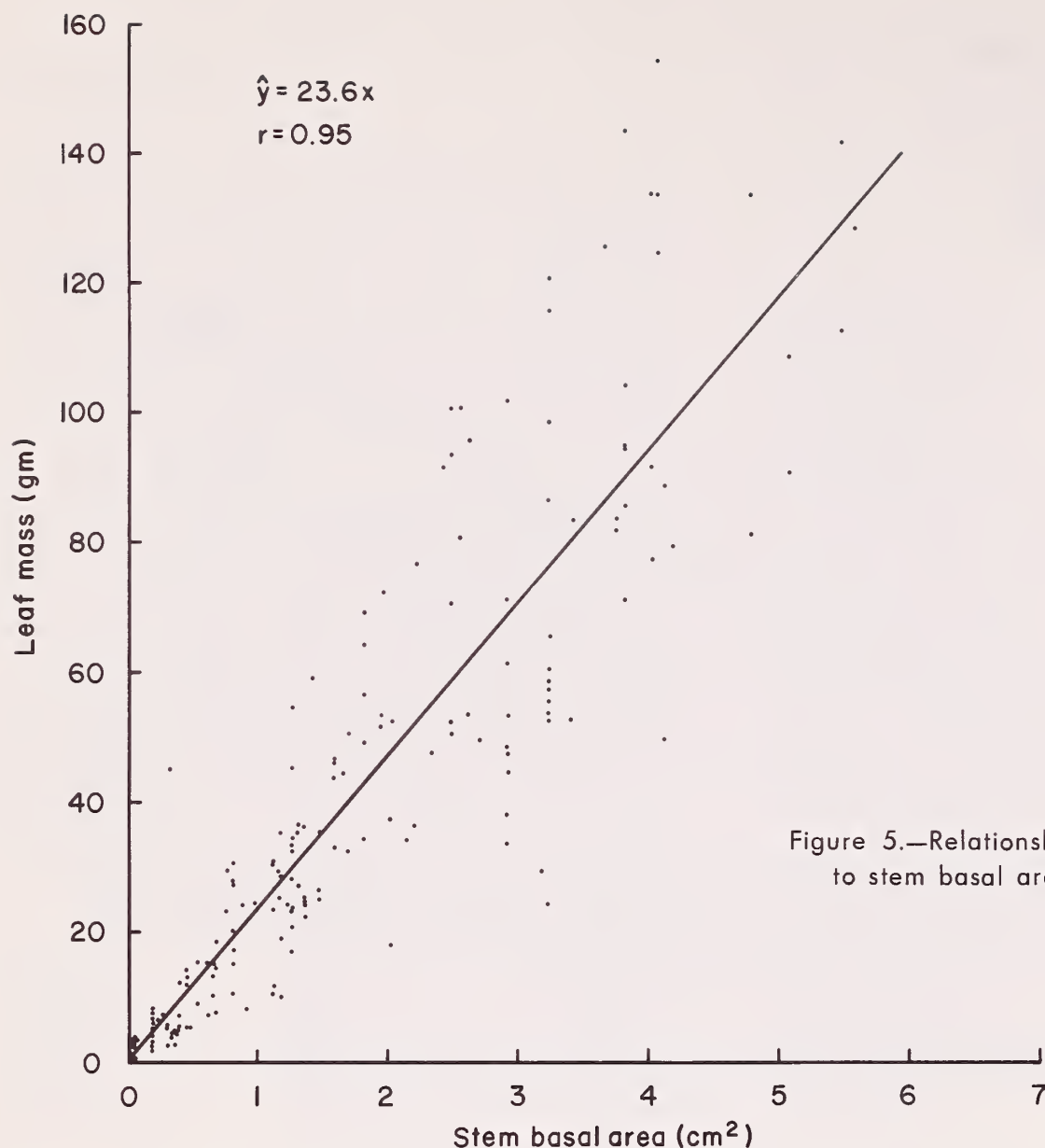


Figure 5.—Relationship of shrub live oak leaf mass to stem basal area.

represent near-maximum weight of forest floor under chaparral in the Sierra Ancha and Mazatzal Mountains.

Moisture Retention Capacity

Moisture-holding capacity of Pringle manzanita litter was significantly higher than shrub live oak litter ($P = 0.05$). Pringle manzanita litter retained 195 percent moisture content, based on oven-dry weight, compared to 180 percent for shrub live oak litter. Applied to the weight of forest floor, this amounted to 5.1 and 4.8 mm depth of water, respectively, under the two types. Because litter mass was slightly greater under shrub live oak, the total water retained per unit area was not significantly different between the two communities. Little "matting" or aggregation of

the litter elements occurred, even during decomposition. Moisture-holding capacity of both manzanita and shrub live oak was greater than Kittredge (1955) reported for related species in California.

Within each community, litter weight varied much more than did water retained per gram of litter, even though the communities were of uniformly high crown cover. Coefficients of variation for litter under manzanita and oak were 56 and 35 percent, respectively. Coefficients of variation for grams of water per gram of litter, on the other hand, were only 11 and 12 percent.

Field moisture capacity as determined probably represents the upper limit for rainwater held in the litter mass. Size and duration of storm, and interval between storms, of course, would directly influence the amount of precipitation retained.

Literature Cited

- Bernard, John M.
1963. Forest floor moisture capacity of the New Jersey pine barrens. *Ecology* 44: 574-576.
- Glendening, George E., and C. P. Pase.
1964. Effect of litter treatment on germination of species found under manzanita (Arctostaphylos). *J. Range Manage.* 17: 265-266.
- Kemp, K.
1965. A study of litter and vegetation in the upper chaparral area of central Arizona. M.S. Thesis, Univ. of Ariz., Tucson.
- Kittredge, Joseph.
1955. Litter and forest floor of the chaparral in parts of the San Dimas Experimental Forest. *Hilgardia* 23: 563-596.
- Pase, Charles P., and Roy R. Johnson.
1968. Flora and vegetation of the Sierra Ancha Experimental Forest, Arizona. U.S.D.A. Forest Serv. Res. Pap. RM-41, 19 p. Rocky Mt. Forest and Range Exp. Stn., Fort Collins, Colo.
- Rowe, P. B.
1955. Effects of the forest floor on disposition of rainfall in pine stands. *J. Forest.* 53: 342-348.

